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Octree Textures

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Octree Textures

What were the goals of this work?

- Reduce non-painting related tasks

Photos of Scott Bonnenfant 3D model painter at ILM

Octree Textures

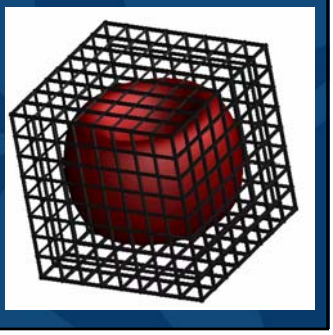
What were the goals of this work?

- Reduce non-painting related tasks
  - Setting up texture coordinates
  - Choosing texture resolutions
- Handle surfaces without a natural parameterization
  - Implicit Surfaces, ADF's
- Simplify mapping of complex surfaces
  - Detailed Polygonal models, Subdivision Surfaces

Octree Textures

What about Volume Textures?

- + Easy Texture coordinate creation
- + Uniform sample density
- - Size grows too quickly (resolution ^ 3)
- - Can't be painted as the samples are distributed through space



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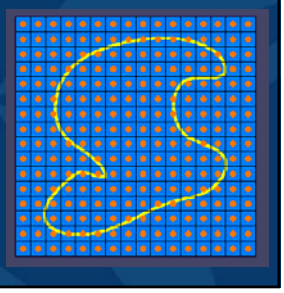
To address the size problem:

- Consider a slice through a volume texture mapping a surface
- Clearly most samples are not being used



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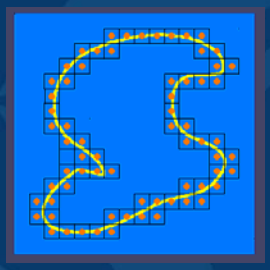
Remove unused samples

- This leaves a sparse subset enveloping the surface
- A regular grid is no longer an good way to store the samples



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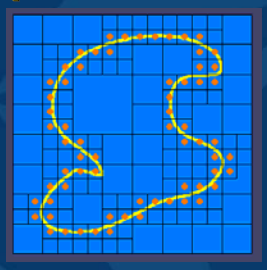
Use an Octree to store samples:

- Efficient data structure for sparse data
- Voxel positions don't need to be stored explicitly



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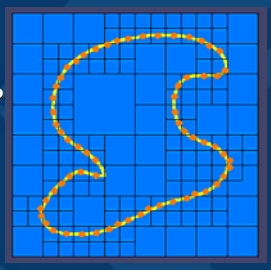
To allow the texture to be painted:

- Move all the samples to the closest points on the surface to their voxels center



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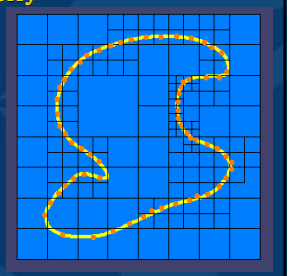
To free the artist from worry about resolution:

- Allow the octree to vary in depth



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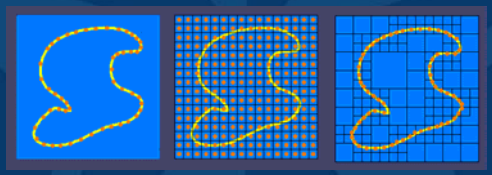
Now we have a new type of texture!

2D 3D Octree



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What are they?

- **Thin Shell of color samples covering a surface**
  - Samples are located at points on the surface
- **Stored as an octree**
  - Efficient structure for storing sparse 3D data
- **Sample looked up by a 3D texture coordinate**

Octree Textures

What do they offer us?

- **Texture coordinates easily generated**
  - Usually the surface rest position
  - 1-1 Mapping to rest surface, such as the hull
- **Uniformly distributed samples in space**
- **High Resolution (Size = k*resolution^2)**
  - At higher resolutions, the size grows like a 2d texture
- **Resolution can vary across texture**
  - Detail where its needed

Octree Textures

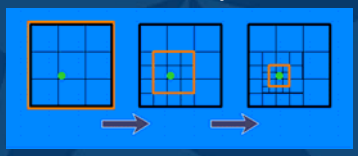
How do we lookup a value?

- **Minification**
  - Extension of mip-mapping to 3D
- **Magnification: Colors at fixed depths**
  - Interpolation through a weighted sum of the neighboring non-empty samples
  - 2 -> Linear 4 -> Bi-Linear 8 -> Tri-Linear

Octree Textures

Magnification: Colors at varying depths

- Interpolation scheme based on paper by Seidel et al.
- Lower resolution areas locally subdivided



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How do we create one?

- **Fill in texture procedurally**
  - Using surface shader
  - Using the results of a simulation
- **Paint with 3D paint system**
  - No 2D representation for traditional paint system to use as an image

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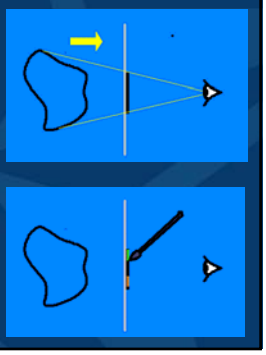
Painting

- **Paint on a rendered projection of the model**
- **Choose a fixed resolution, or the resolution based on the screen area**



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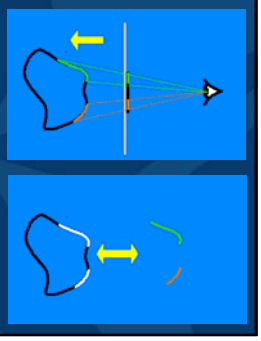
Painting

- **Rasterize the parameter space representation of the surface into the octree**
- **Match the resolution of the existing texture and the new paint**
- **Cull any voxels that don't intersect the surface**



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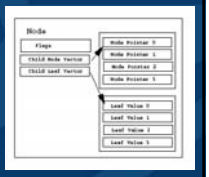
Implementation



- Compact pointer based octree
- Variable sized nodes which contain the leaves
- Compact depth first file format for paint
- Tiled breadth first format for rendering with average colors at nodes
- Integrated in existing 3d paint system
- Plugin shaders for Renderman and Mental Ray

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Problems

- Color Bleeding
- Need 3d paint system to create
- No 2D image for artists to look at
- Slightly larger than 2D textures
- More expensive to lookup
- No direct hardware support at present

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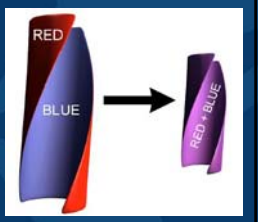
How do we avoid color bleeding?

- Split model between different textures.
- Edit the texture coordinates to move sections of the model apart.



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When do we need to do this?

- Parts of a model that may move like eyes.
- Parts that intersect, like a hat and a head
- Surfaces that are close together like the front and back of a piece of paper
- Parts of a model that have very different colors. For example the front may be red and the back may be blue

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What do the artists think of them?

- Another tool in their toolbox
- Useful for complex machines that would be difficult to set up
- Useful for background items that must be painted quickly
- They still prefer traditional 2D textures for hero characters

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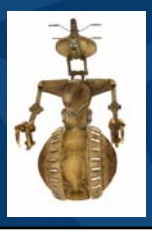
What have they been used on?

- Episode II (Droids, Jarjar's medalion)
- AI (City in the sea)



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Future Work

- **Hardware Texture support**
  - First step might be to view octree textures as a special kind of compression scheme for volume textures.
- **Smoother interpolation**
  - Store and use sub-voxel sample position

Octree Textures

Acknowledgements

- **Thanks to ILM for letting us publish this work**
- **Thanks to the 3D Model painters for working with us to get this new technology used.**